National Aeronautics and Space Administration

NASA

Science @ Marshall Space Flight Center

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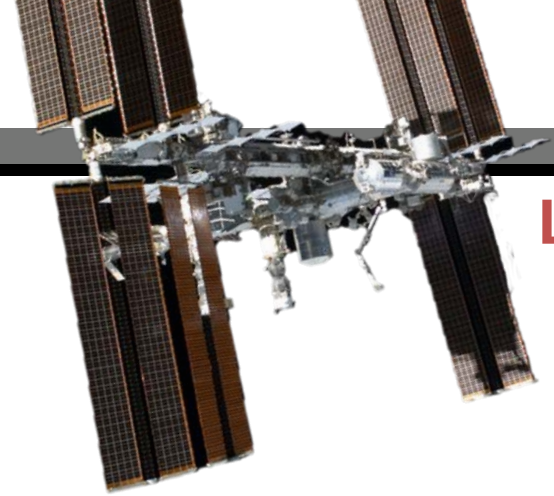
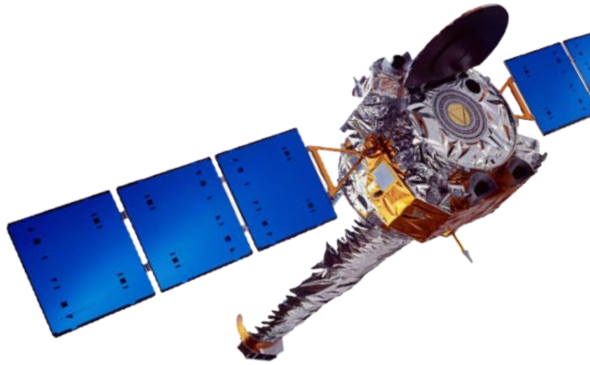
Chief Scientist, MSFC
Science and Technology Office

October 22, 2016
StarFest, Bays Mountain, TN

MARSHALL
SPACE FLIGHT CENTER



Living and Working in Space



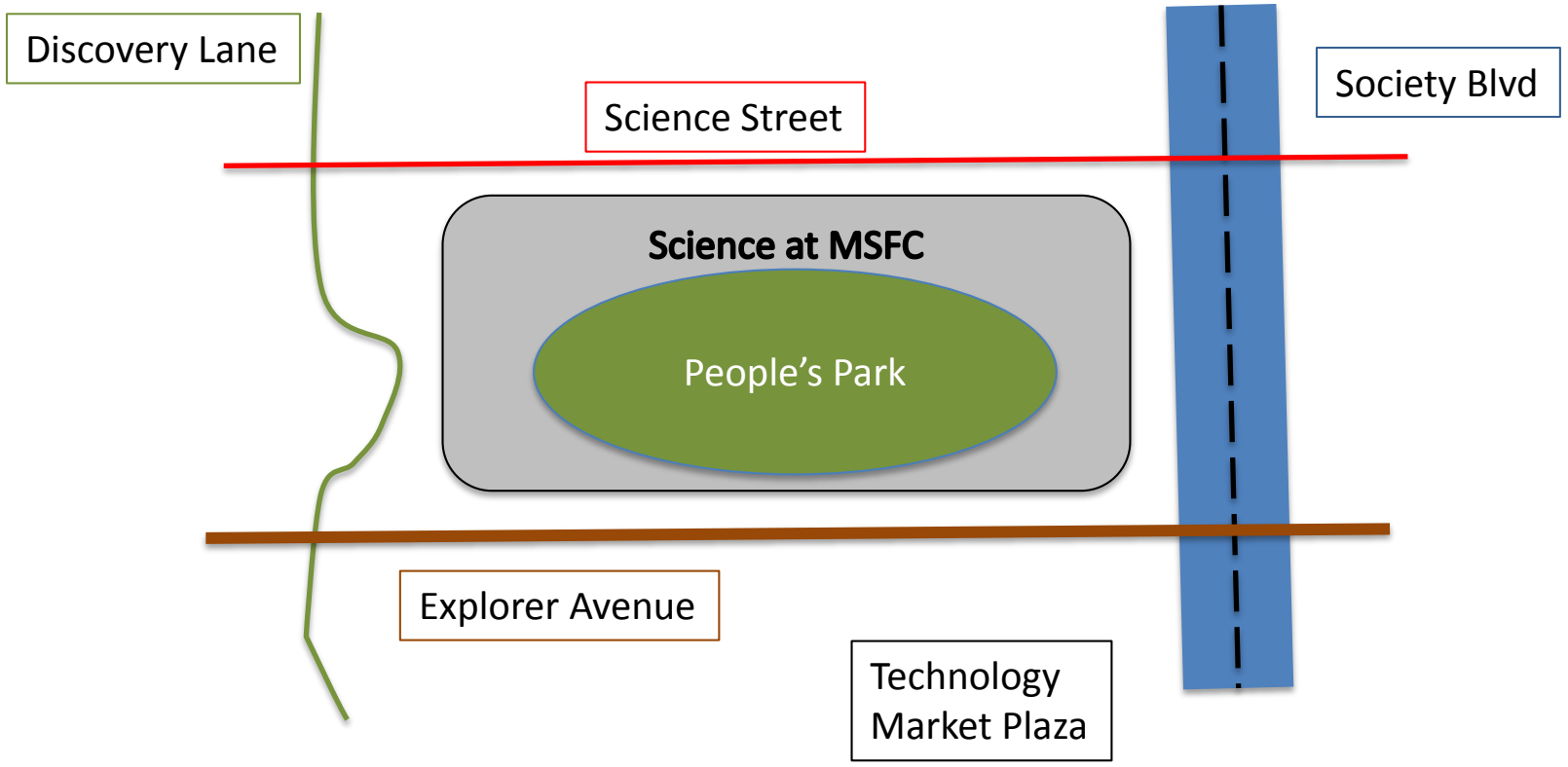
Understanding Our World and Beyond

Traveling To and Through Space

Marshall's Mission Areas

Science @ MSFC Neighborhood

At the MSFC Science Research Office we don't investigate everything, but what we choose to pursue, we do with excellence to the benefit of NASA, the Nation, and humanity, employing a motivated community of expert people who are fully committed to success and engaged in the task.



3 Things We Do

Three things that Science @ MSFC provides to their primary customer

- **Program/Project Management**
- **Build and Fly Flight Hardware**
- **Scientific Research**

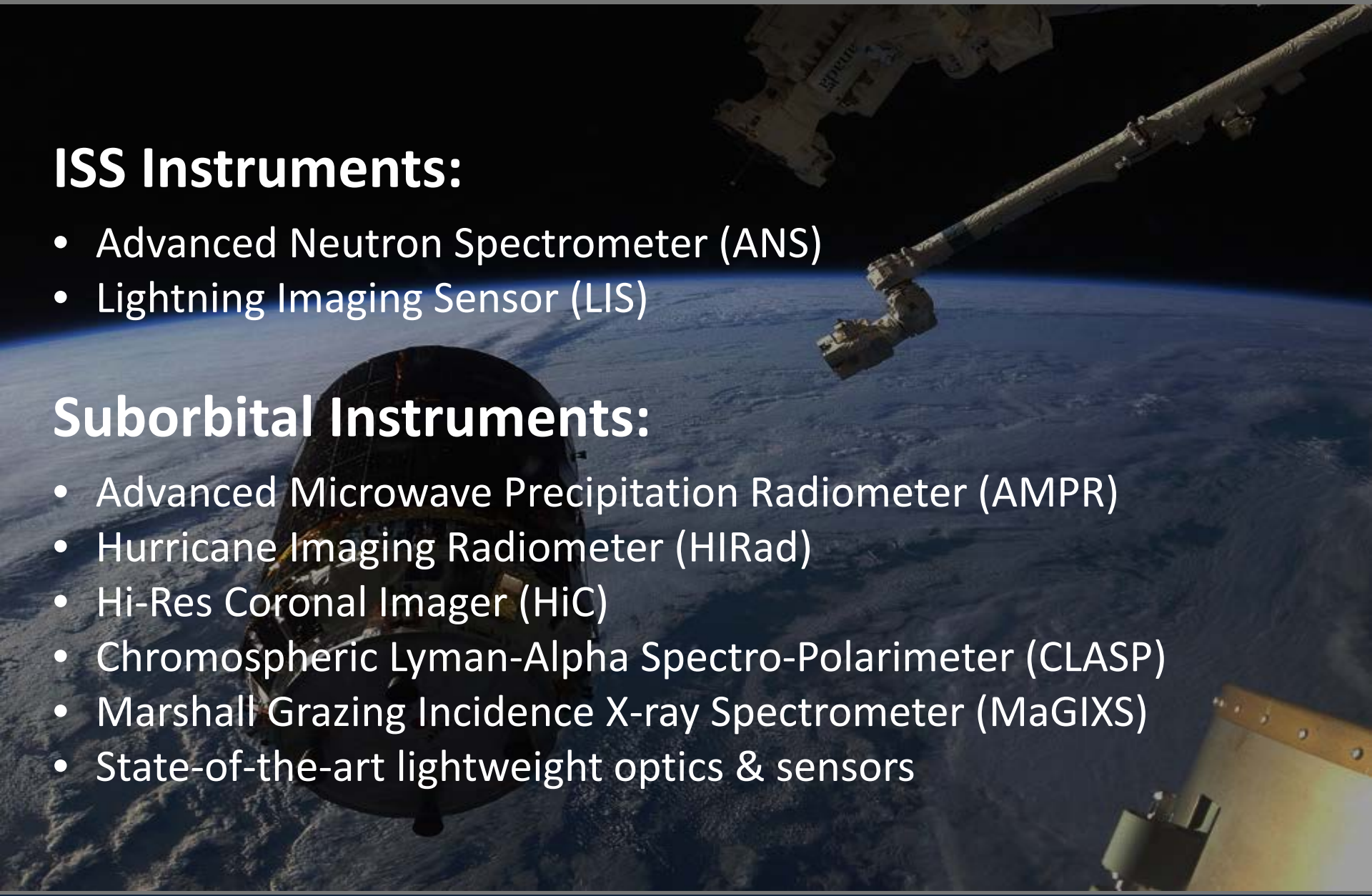
Program/Project Management

Marshall leads one of four 2020 Decadal Survey Large Mission Concept studies:
X-Ray Surveyor

Manages major NASA missions:

- Chandra
- Hinode
- SERVIR
- Planetary Missions Program Office (including Europa mission)

Flight Hardware



ISS Instruments:

- Advanced Neutron Spectrometer (ANS)
- Lightning Imaging Sensor (LIS)

Suborbital Instruments:

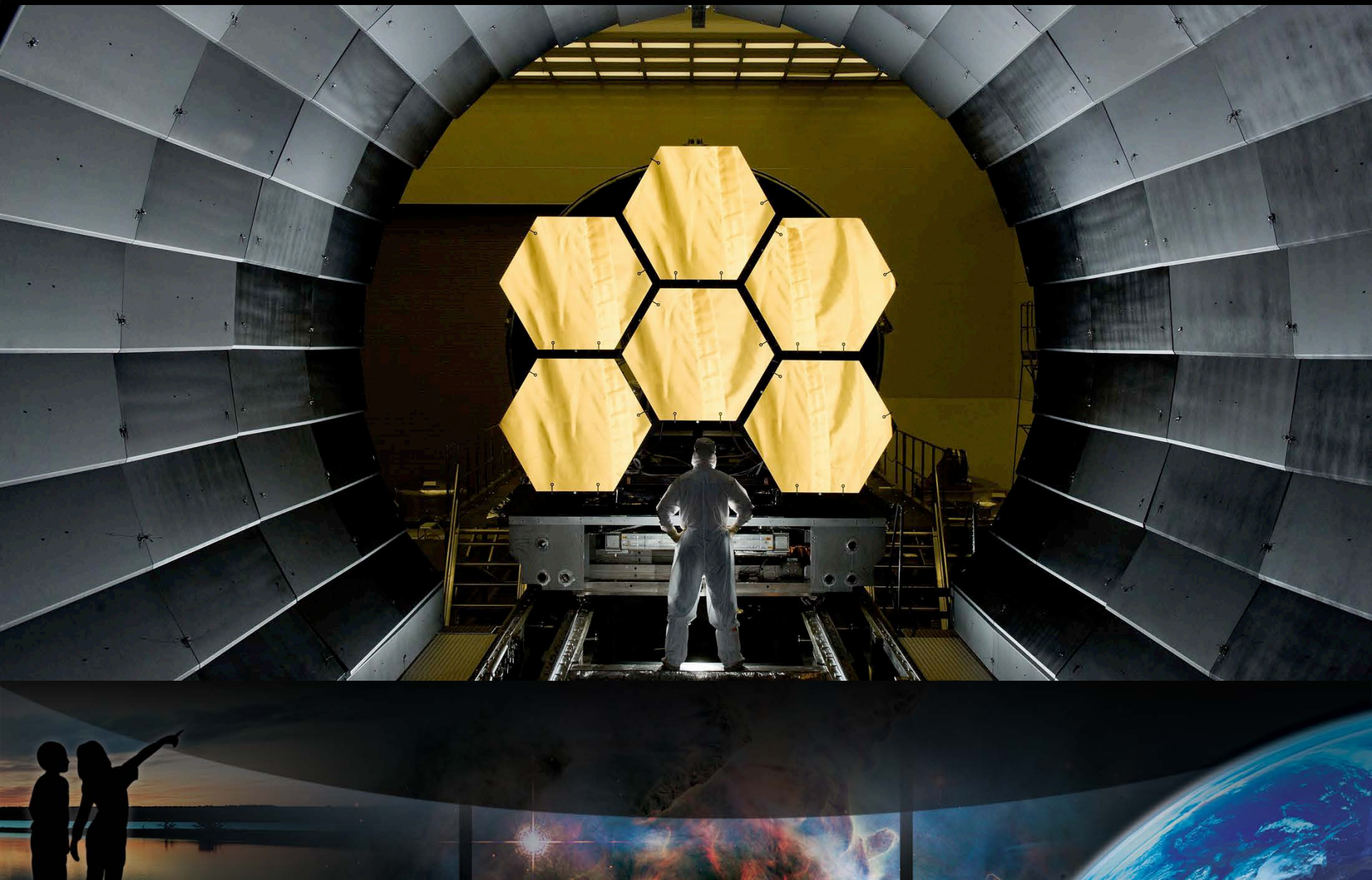
- Advanced Microwave Precipitation Radiometer (AMPR)
- Hurricane Imaging Radiometer (HIRad)
- Hi-Res Coronal Imager (HiC)
- Chromospheric Lyman-Alpha Spectro-Polarimeter (CLASP)
- Marshall Grazing Incidence X-ray Spectrometer (MaGIXS)
- State-of-the-art lightweight optics & sensors

Scientific Research

- **MSFC Fermi-GBM observed a gravitational wave event counterpart to NSF's Laser Interferometer Gravitational-Wave Observatory (LIGO)**
- **SPoRT enables NASA Earth science observations for societal benefit**
- **Marshall's research into the intricate activity of solar X-ray jets published in Nature**
- **Marshall scientists are breaking new ground with X-ray polarimetry technique – This is the IXPE Explorer Proposal**
- **Planetary activities:**
  - Mars Science Lab (Participating Scientist)
  - Lunar Flashlight (Science Lead)
  - InSight (CoI)

NASA SCIENCE

Seeking Answers to Fundamental Questions



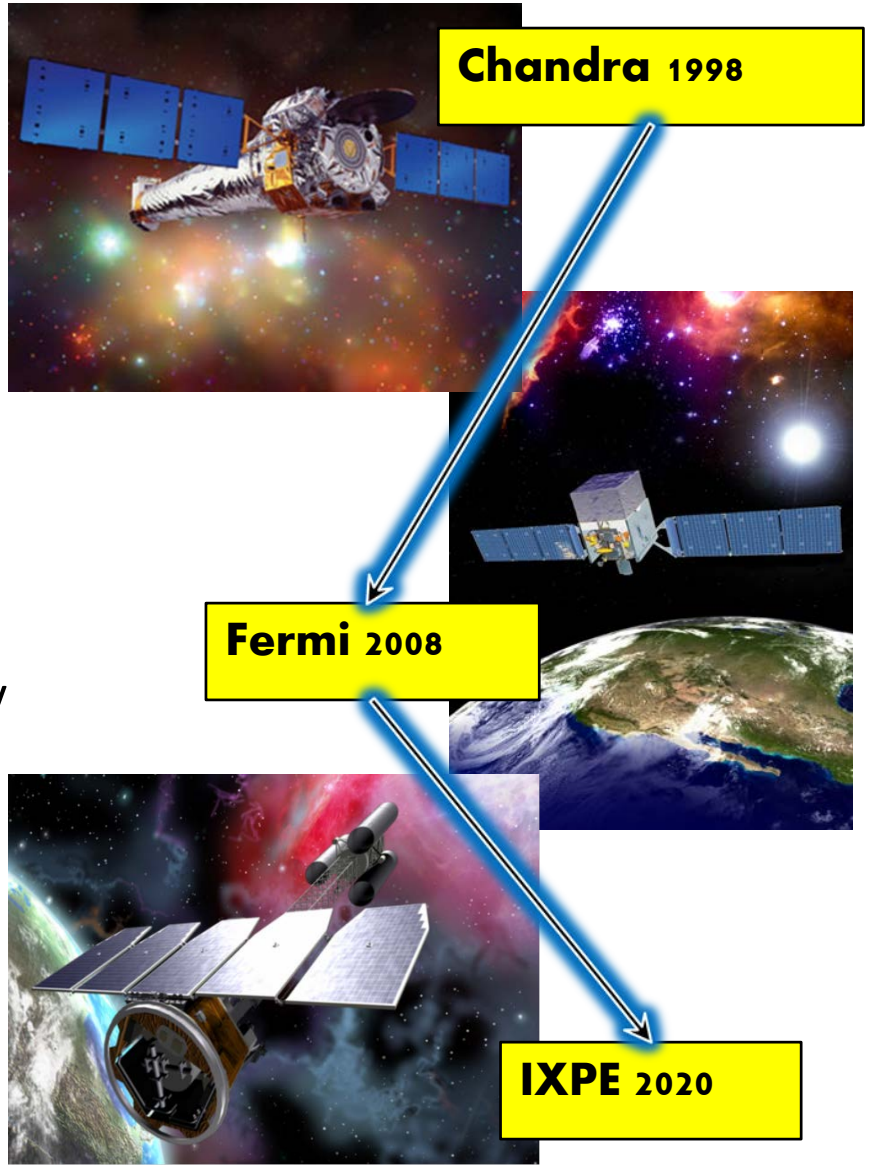
5 Research Focus Areas

- **High Energy Astrophysics** – peering back to the earliest epochs of the Universe to unravel its mysteries and studying the most violent explosions in space in our galaxy and beyond
- **Heliophysics and Space Weather** – seeking to understand what triggers solar storms and how they impact the near-Earth space environment and space assets
- **Planetary Science** – discovering the genesis and evolution of the inner solar system bodies
- **Earth Science Research and Analysis** – studying the Earth as a system with a focus on its climate and energy and water cycles
- **Earth Science Applications** – applying NASA's Earth observations, models, technologies, and expertise to benefit society

MSFC Astrophysics

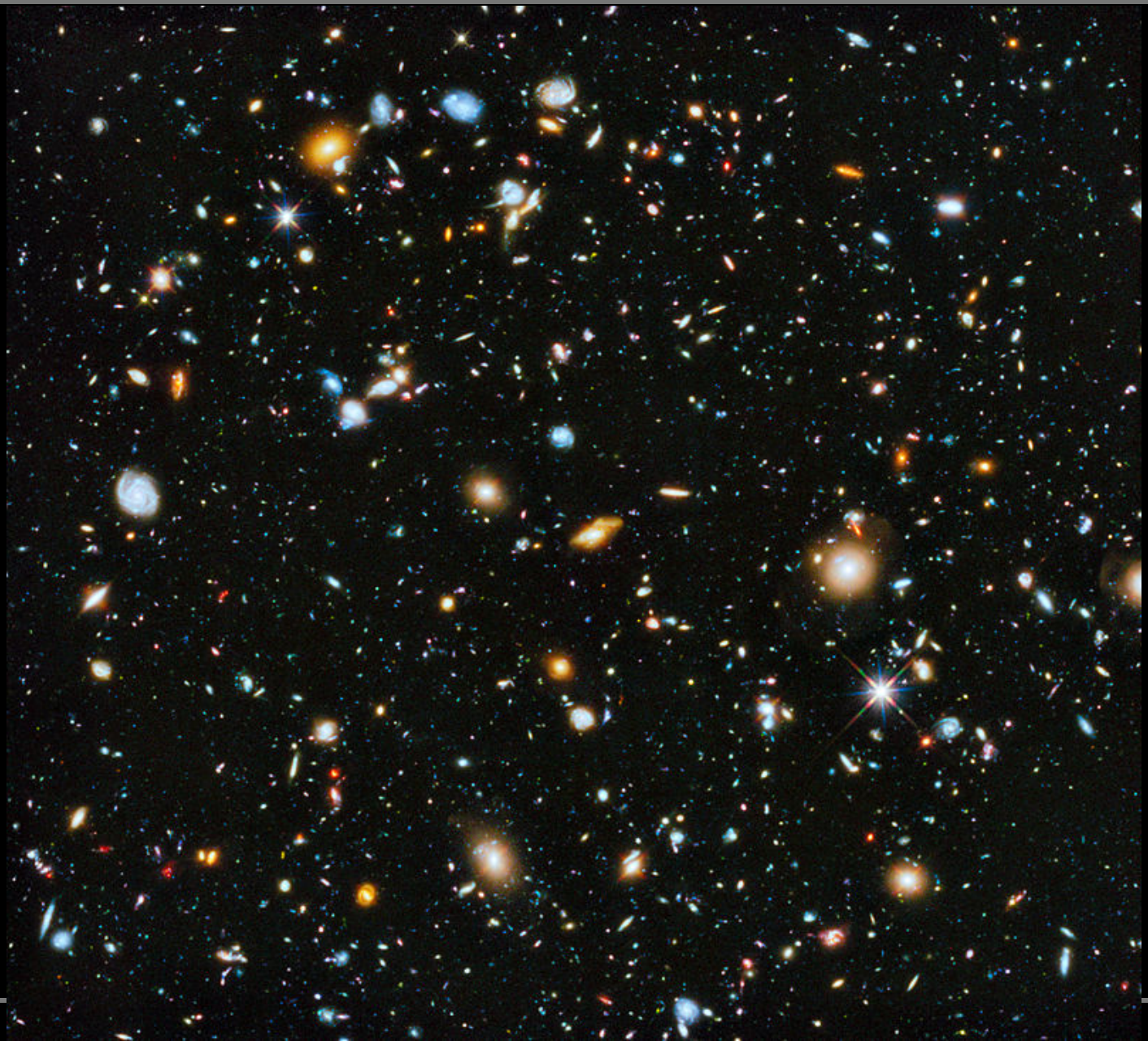
Mission: (1) to provide NASA expert science advice and capable leadership in the area of high-energy astrophysics, (2) to conduct world-class basic research in astrophysics and related areas, and (3) to enable MSFC and NASA to achieve its strategic science goals

Vision: (A) to be known as NASA's premier high-energy capability for development, test, and calibration of detector technology and optics for sub-orbital and space-based observatories, (B) to continue to be recognized as a source of future astrophysicists and technologists with theory, data, modeling and hands-on hardware experience, and (C) to manage NASA's Strategic X-ray missions



Astrophysics

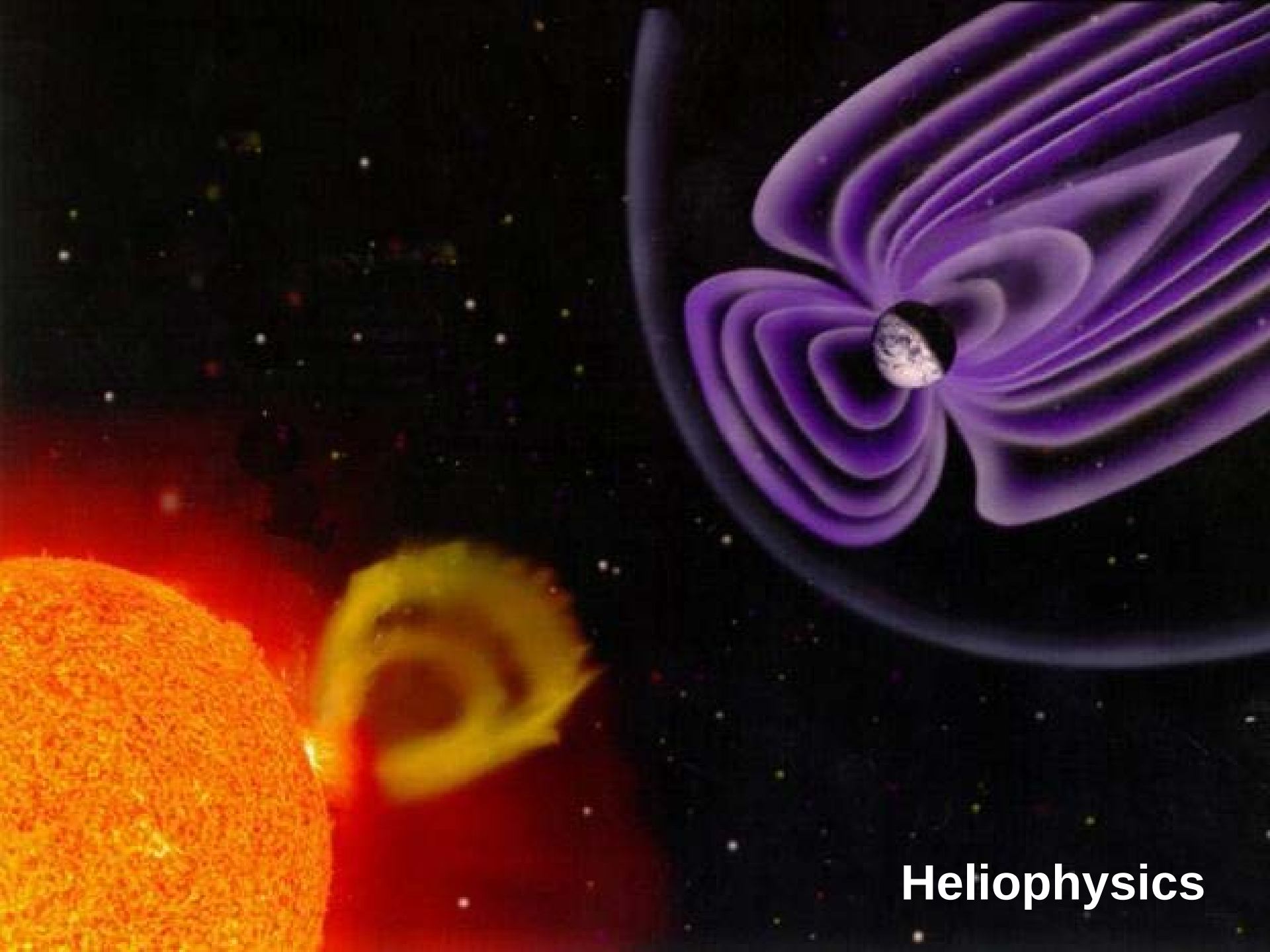
Hubble Ultra-Deep Field camera



Chandra X-ray Observatory

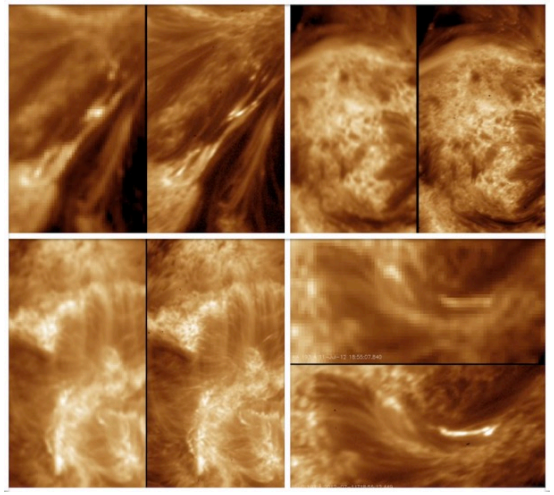
BLACKHOLE MERGER

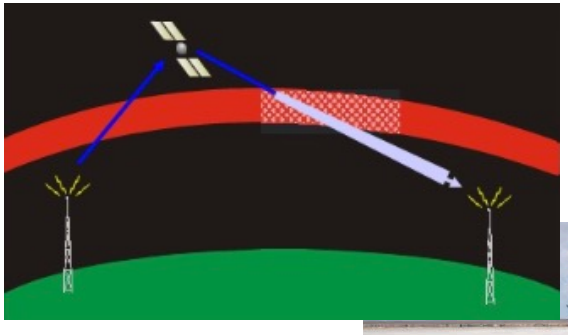
Galaxy Cluster CL J1001+0220


Heliophysics

MSFC Heliophysics Mission: To advance our understanding of the sun's magnetic atmosphere and of the terrestrial atmospheric and space plasma variability, in order to improve our ability to predict their dynamical behavior.

Vision: 1) Develop, test, and calibrate space flight hardware (sounding rocket & CubeSat instrumentation and detectors) building towards MSFC PI-led missions, 2) maintain a diverse group of scientists to analyze data and perform supporting theoretical modeling.

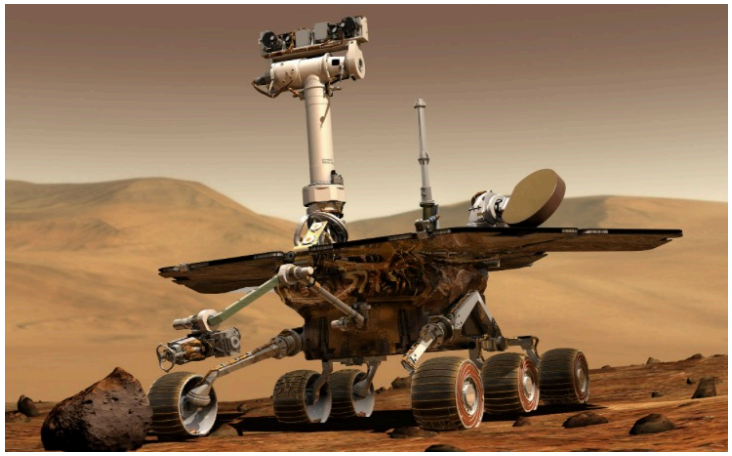


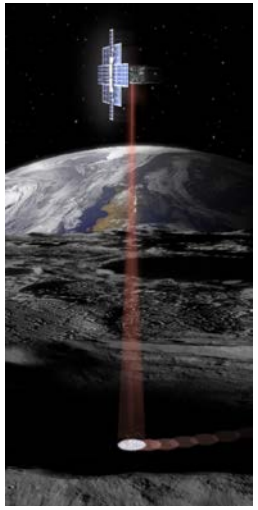


Planetary Science

MSFC Planetary Science Mission: Provide expertise to the planning and execution of NASA human and robotic missions.

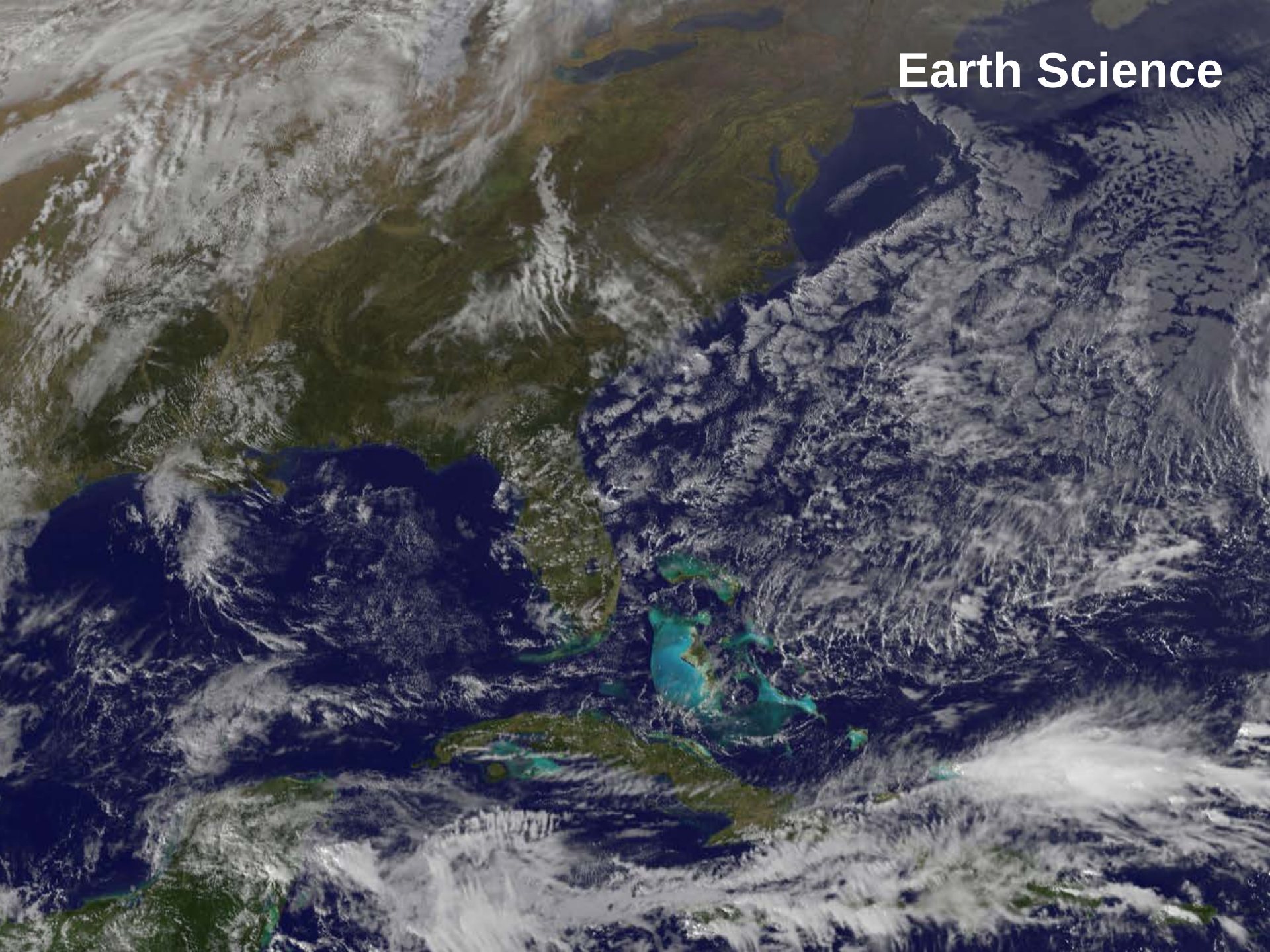
Vision: Maintain a group of experts in planetary surfaces, atmospheres, and interiors to conduct externally-funded, competitive research and work within Marshall and Agency programs and projects that send assets to planetary destinations such as the Moon, Mars, and asteroids.





Earth

Earth
Moon


Earth Science

Earth Science Office

Our Mission

Integrating unique space-borne observations, data, and models, we

- ***advance understanding*** of the Earth's weather and its energy and water cycles,
- ***develop scientific and technical solutions*** to challenging coupled Earth-atmosphere systems problems, and
- ***transition research*** to applications that enable decision support ***for societal benefit.***

Our Vision

Expand our role as Agency ***leaders and innovators*** of Earth science discovery and focused technology development for capacity-building and societal benefit.

Thematic Research Emphasis

Lightning
Precipitation
Data Informatics
Climate Studies
Atmospheric
Dynamics
Surface Processes

Hardware Development

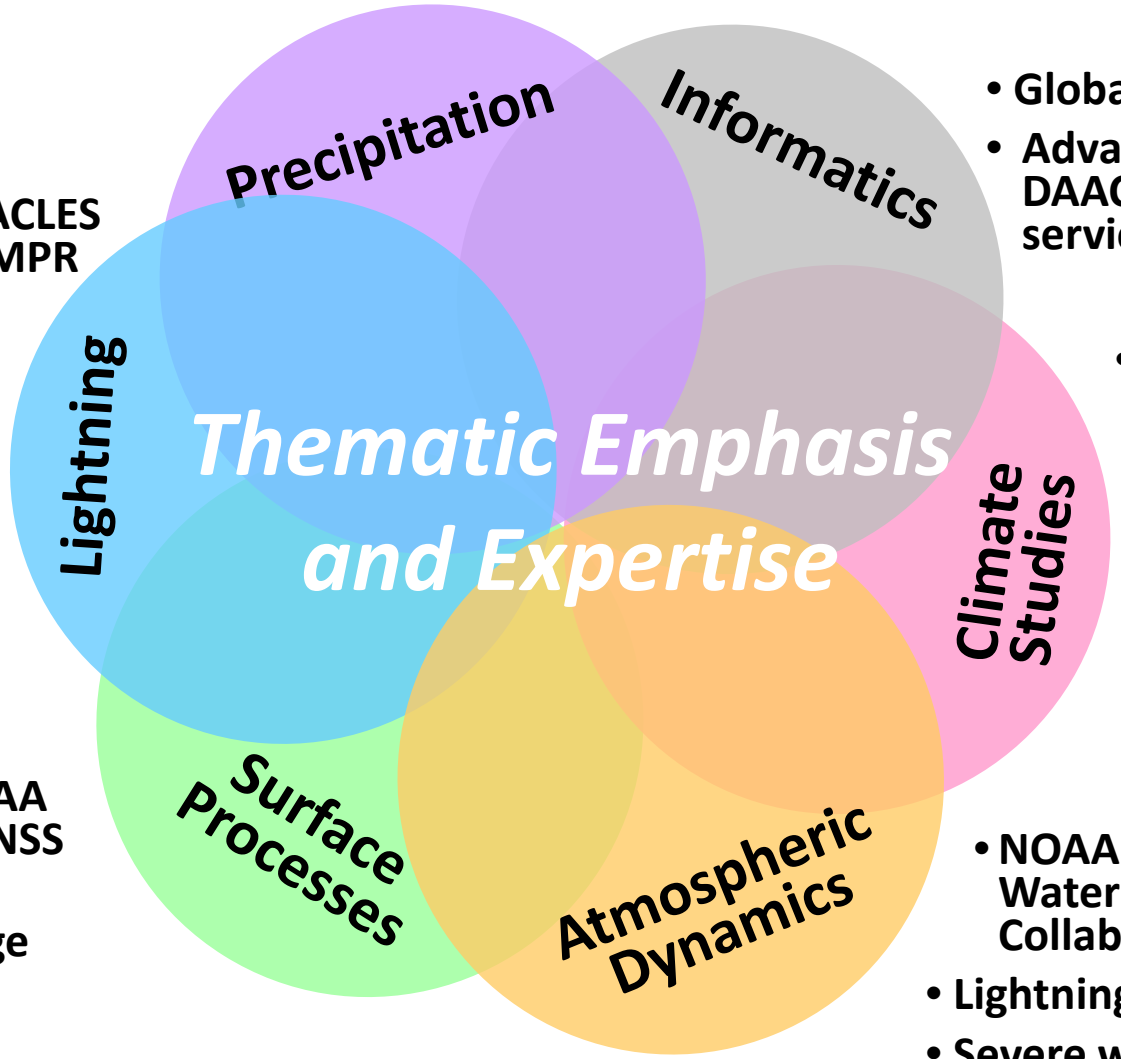
LIS, ISS LIS
AMPR, HIRad, FEGS

Enabled Programs

SERVIR
SPoRT
NOAA Support

Earth Science Office

Competed, directed, and reimbursable (NOAA, DoD, USAID)



- GPM validation activities
- OLYMPEX / ORACLES support with AMPR

- Global Hydrology DAAC
- Advanced design for DAACs using cloud services

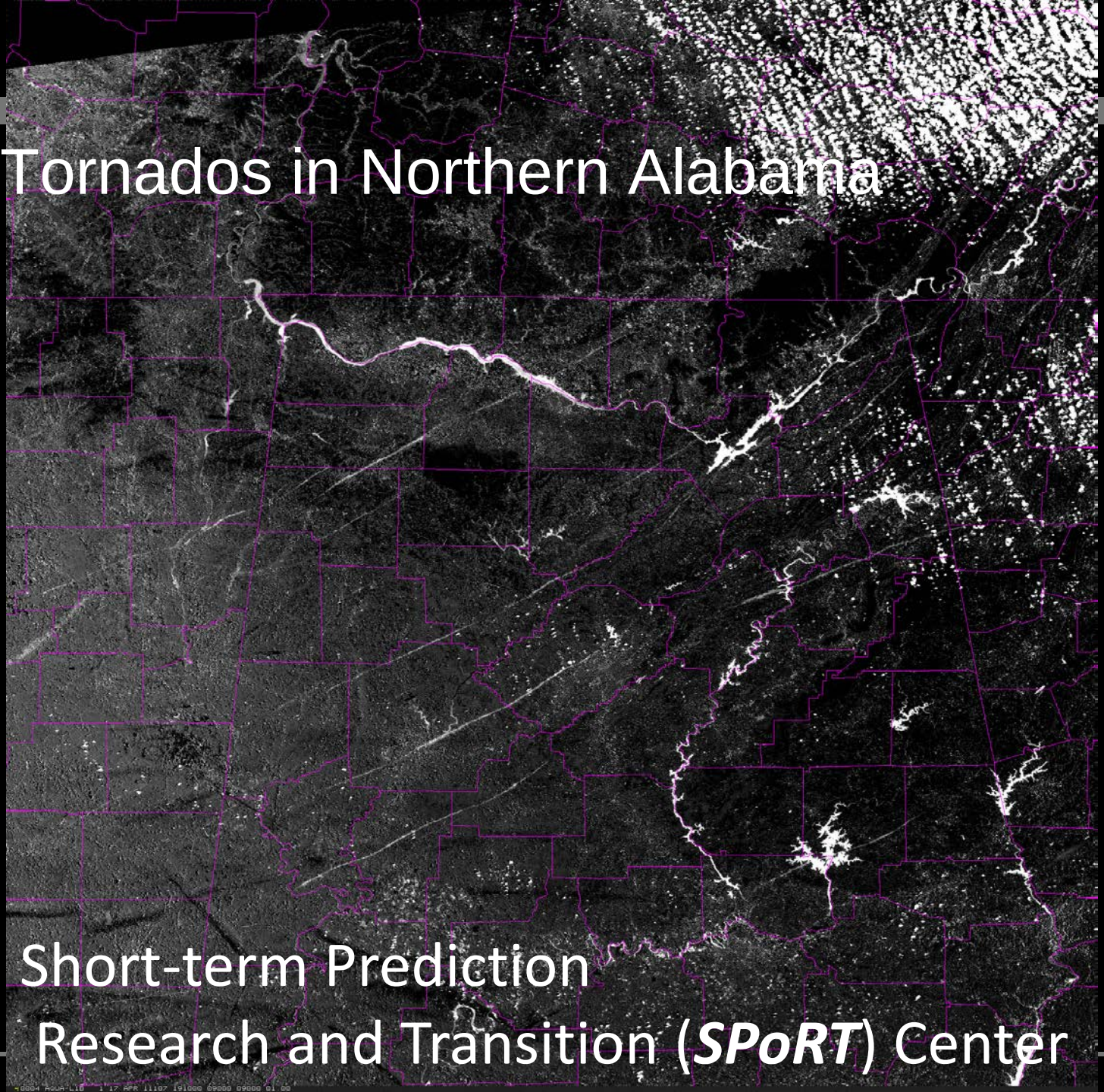
- LIS, ISS LIS
- Severe weather and lightning safety

- Uncertainties in long-term data sets
  - Tracking vector-borne Zika
  - Climate affects on public health

- HIRAD winds supporting NOAA and NASA CYGNSS missions
- Disaster damage detection

- NOAA National Water Center Collaboration
- Lightning energetics
- Severe weather

2011 Tornados in Northern Alabama



Short-term Prediction
Research and Transition (***SPoRT***) Center

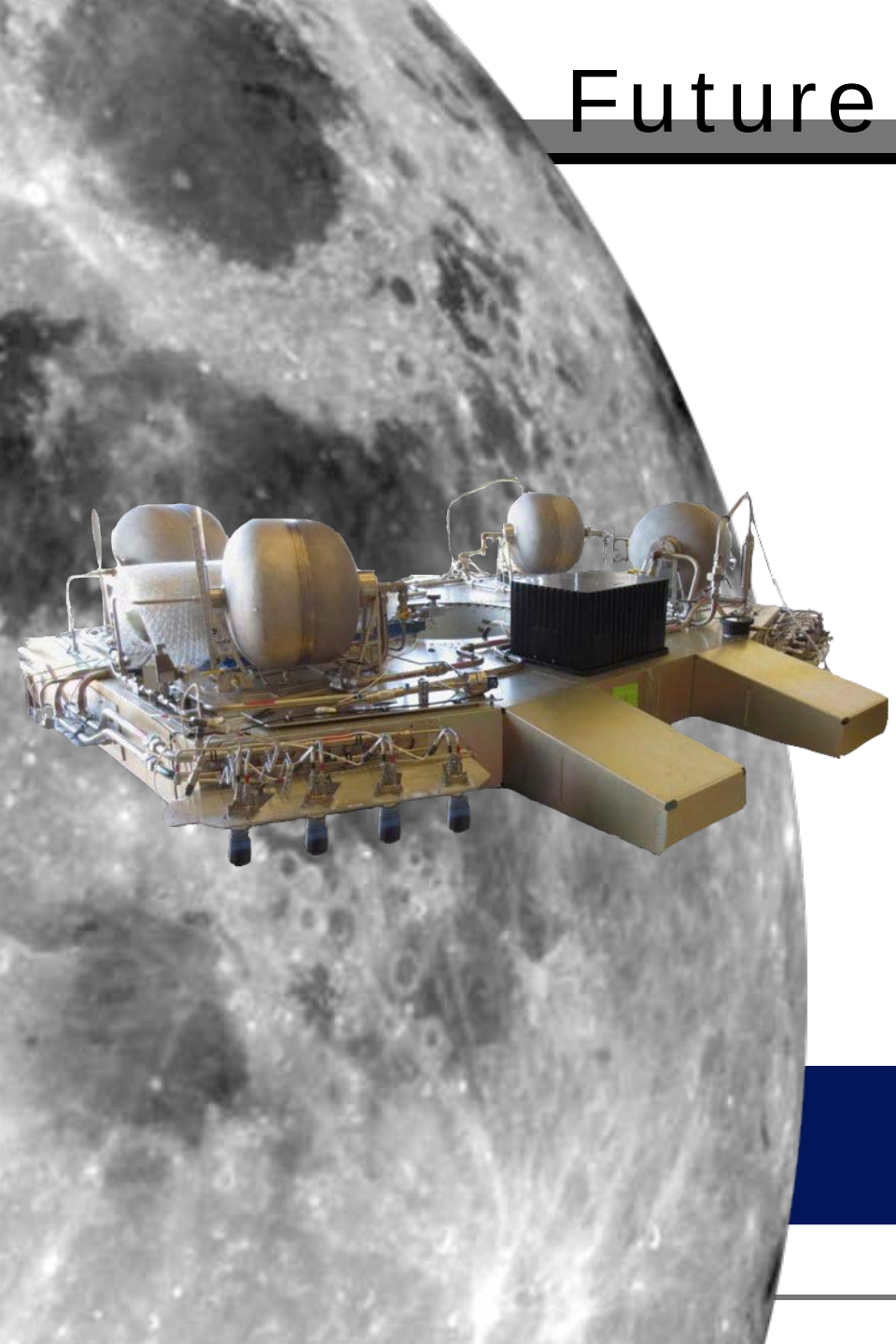
Climate Change

SERVIR

https://youtu.be/dWgPM87LrLM

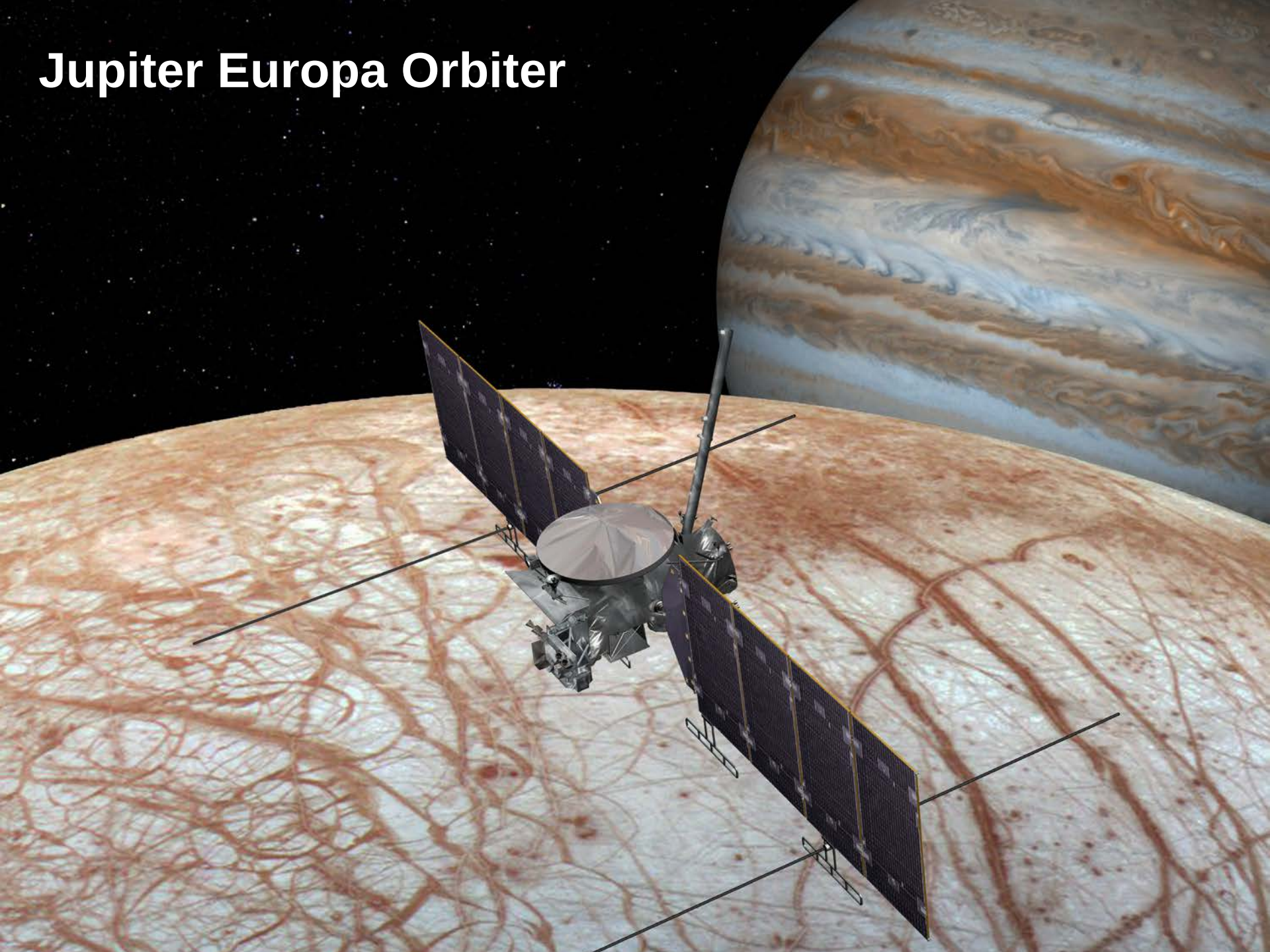
Science and the International Space Station

Future Missions

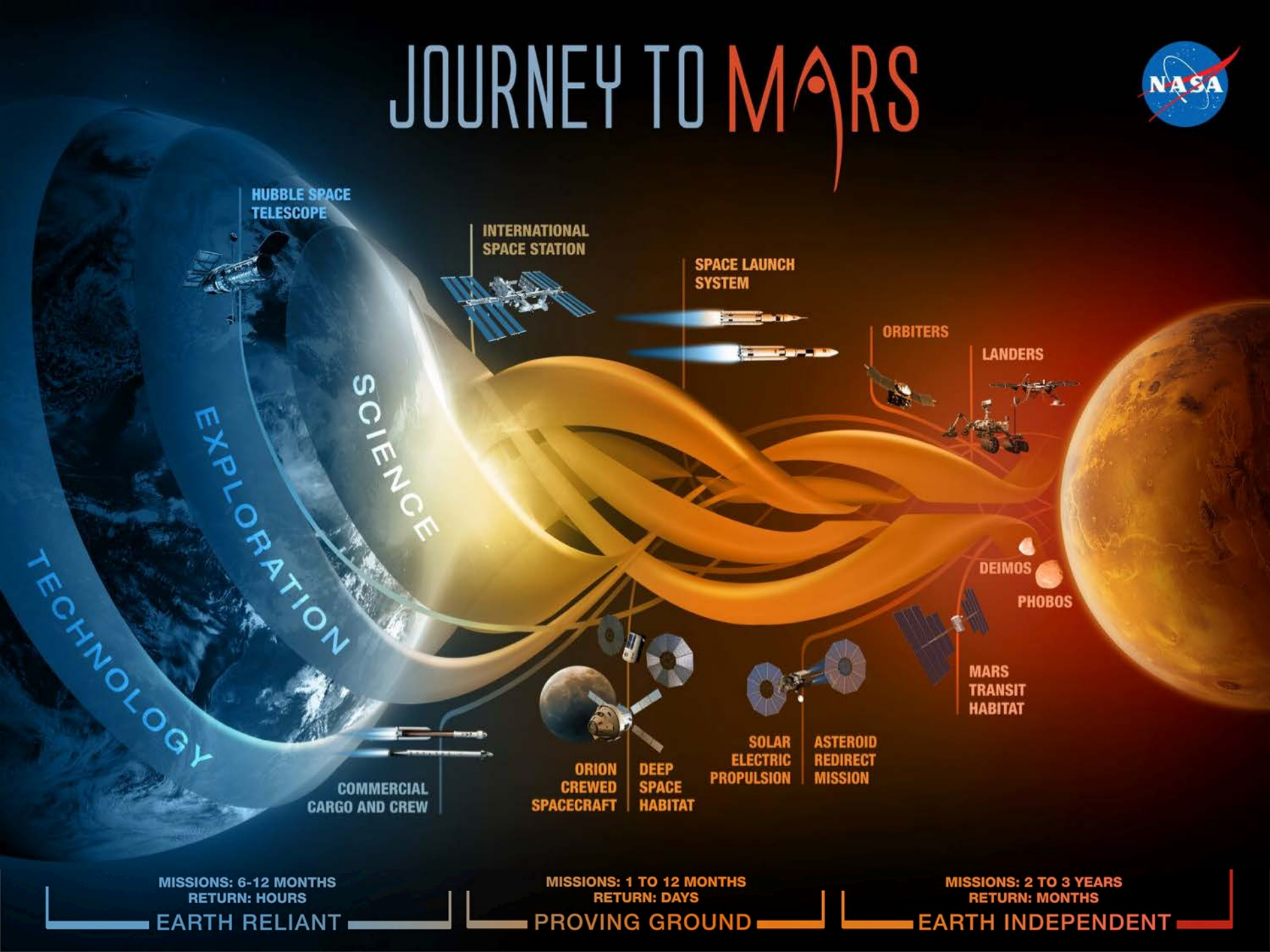


Resource Prospector

Jupiter Europa Orbiter



JOURNEY TO MARS



MISSIONS: 6-12 MONTHS
RETURN: HOURS
EARTH RELIANT

MISSIONS: 1 TO 12 MONTHS
RETURN: DAYS
PROVING GROUND

MISSIONS: 2 TO 3 YEARS
RETURN: MONTHS
EARTH INDEPENDENT

How do we do this?

With a lot of care, dedication, ingenuity, commitment, and support

Science @ MSFC Neighborhood

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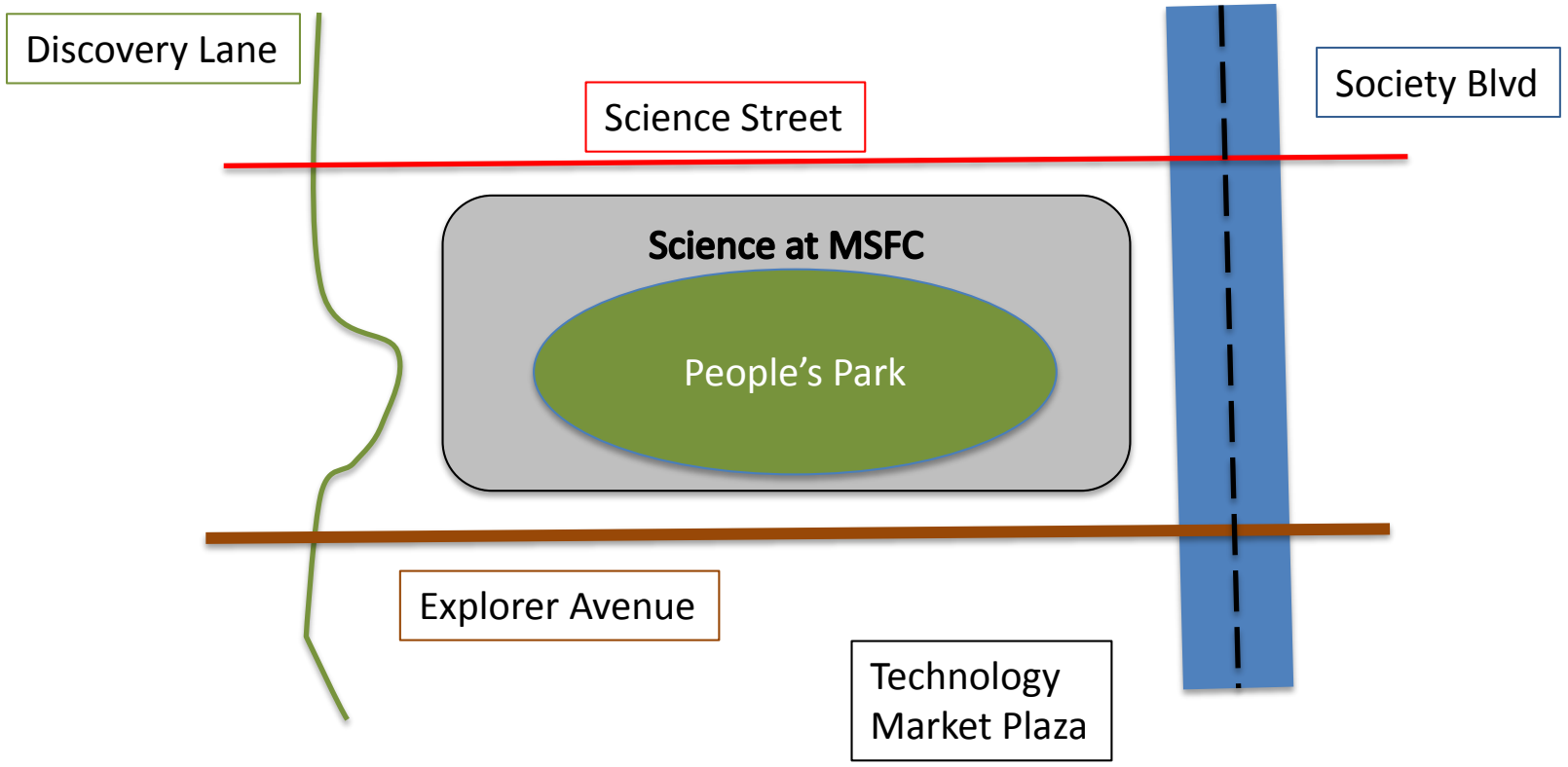


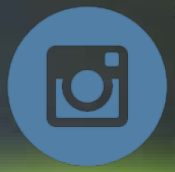
INNOVATE EXPLORE DISCOVER INSPIRE

Science @ MSFC

Questions?

nasamarshallcenter

@NASA_Marshall


@NASA_Marshall

NASAMarshallTV

nasamarshall

BACKUP SLIDES

MSFC Astrophysics

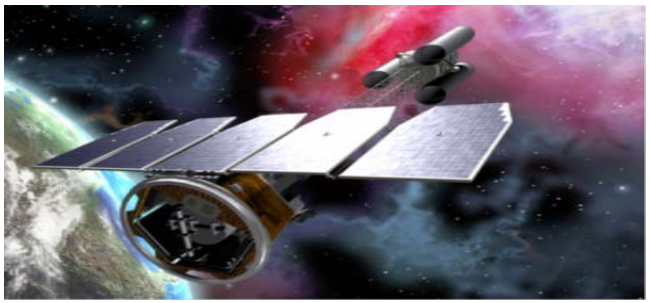
MSFC is responsible for **Chandra**'s

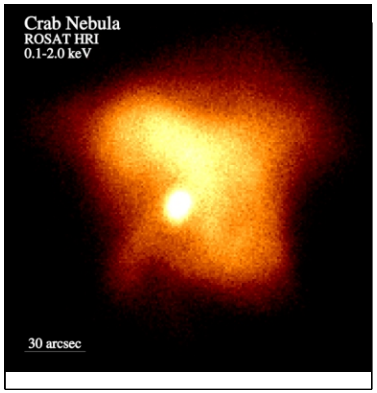
- *program management*
- *science support*
- *engineering support*

MSFC is responsible for **Fermi**'s GBM

- *monitoring the instrument*
- *data validation*
- *making data available to the community*

MSFC developed the science of **x-ray polarimetry** behind the SMEX mission **IXPE**





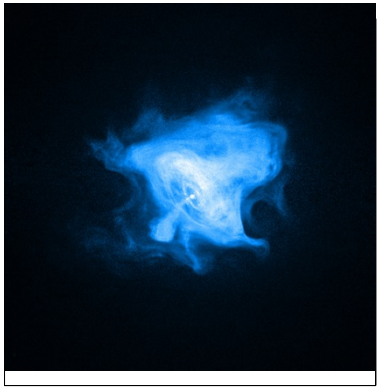


Image of the Crab Nebula before and after Chandra…

MSFC Astrophysics

MSFC is developing the next generation of x-ray optics

MSFC has developed a first of its kind neutron monitor (FSN) for the ISS

MSFC is developing a unique x-ray/gamma-ray polarimeter (LEAP) for the ISS with UNH

MSFC supports numerous sub-orbital and space missions via national and international partnerships

MSFC leads the Astrophysics Decadal mission study team X-ray Surveyor, and has a role in each of the other 3 study team.

MSFC Heliophysics

Mission support

- Hinode Project Scientist and data analysis
- Co-I on Solar Wind Electrons Alphas and Protons (SWEAP) instrument on Solar Probe Plus
- Supporting various National Space Weather Action Plan (SWAP) studies and NOAA Space Weather Follow-On mission concept assessments

Sounding rocket program

- CLASP/CLASP2: Chromospheric Lyman-Alpha SpectroPolarimeter
- MaGIXS: Marshall Grazing Incidence SpectroPolarimeter
- ESIS: EUV Snapshot Imaging Spectrograph
- Hi-C: Hi-Resolution Coronal Imager (1, 2, 3)

Technology development

- EUV and X-ray spectrometers, plasma particle and wave detectors, energetic particle and electric field sensors, GPS discriminator

MSFC Heliophysics

Science investigations

- Solar surface magnetic field investigations – magnetograph analysis and modeling
- Plasmasphere modeling
- Space environment models for prediction of all-clear scenarios for human exploration events, and tether systems
- Software tools for mining large multivariate space weather data sets

Collaborative Concepts

- Space Environments and Space Weather coordination concept for NASA
- Science to Applications Program for space weather science transition
- US-Brazil mission concepts

MSFC Planetary Science

Mission support

- Mars Exploration Rovers (Operations), Mars Science Laboratory (Participating Scientist), InSight (Co-Investigator), Cassini (Science Team)
- Field campaigns in support of mission planning for human surface activities
- Robotic & Human Exploration Science Workshop concept formulation with SMD and HEOMD

SLS/Advanced Concepts Integration

- Lunar Flashlight (Principal Investigator), NEAScout (Principal Investigator)
- Two scientist liaisons/destination SMEs

Facilities

- MSFC Noble Gas Research Laboratory (MNGRL) – Geochronology of lunar rocks, meteorites, and terrestrial impact rocks
- Dusty Plasma Laboratory

MSFC Planetary Science

Technology development

- Potassium (K) – Argon Laser Experiment (KArLE) flight instrument for in situ planetary geochronology

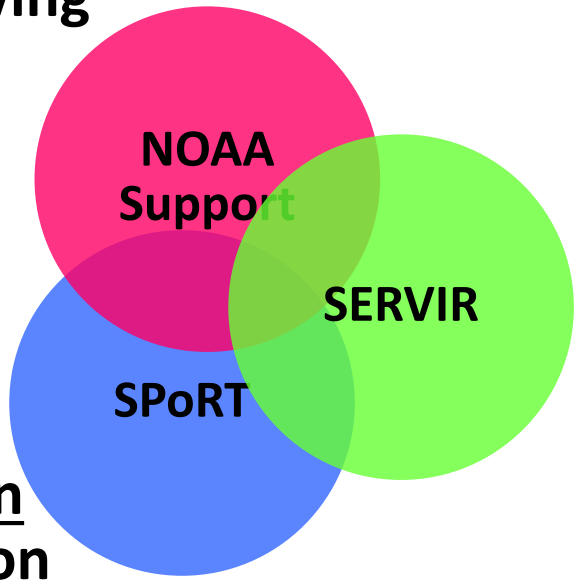
Science investigations

- Surface processes (weathering, impacts, geology, geomorphology, composition, age) and interior structure of terrestrial planets, moons, and asteroids
- Dust/atmospheric dynamics of the outer planets, rings, and satellites
- Planetary analog studies/ISRU

Earth Science Office Enabled Programs

Support to NOAA

- GOES-R Validation and AWG
- GOES-R and JPSS Proving Grounds



SERVIR

International capacity-building for disaster preparedness and in response to climate change

Short-term Prediction Research and Transition

Transition NASA data and research capabilities to improve weather forecasts